

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels

PURPOSE

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. The practice applies to all types of structures, including a combination of earth embankments and principal spillways and full-flow or detention-type structures. This practice also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel.

CRITERIA

The structure must be designed for stability after installation. The crest of the inlet must be

set at an elevation that stabilizes upstream head cutting.

Embankment dams. Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 ft in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60, Earth Dams and Reservoirs (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 ft or less shall meet or exceed the requirements specified for Ponds (378).

The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway (earth spillway) crest and the lowest point in the cross section along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

Pond size dams. If spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of detention storage.

Table 1. - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet *at the crest elevation of the auxiliary spillway*.

Maximum drainage area for indicated rainfall ¹			Effective height of dam	Frequency of minimum design, 24-hour duration storm	
0-3 in.	3 - 5 in.	5+ in.			
-----acres-----			ft	yr	
200	100	50	35 or less	2	
400	200	100	20 or less	2	
400	200	100	20 - 35	5	
600	400	200	20 or less	5	

¹In a 5-year frequency, 24-hour duration storm

If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre-ft, the must be used as the minimum design storm.

Grade stabilization structures with a settled fill height of less than 15 ft and a 10-year frequency, 24-hour storm runoff less than 10 acre-ft, shall be designed to control the 10-year frequency storm without overtopping. The principal spillway, regardless of size, may be considered in design and an auxiliary spillway is not required if the combination of storage and principal spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for Water and Sediment Control Basins(638) rather than the requirements for Ponds (378).

Full-flow open structures. Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Handbook for Conservation Practices, the National Engineering Handbook, and other applicable NRCS/SCS publications

and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction because of detention storage. Structures must not create unstable conditions upstream or downstream. Provisions must be made to insure safe re-entry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 4 ft or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Table 2. – Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall ¹			Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 – 3 in.	3 – 5 in.	5+ in.		Principal spillway capacity	Total capacity ²
-----acres-----			ft	yr	yr
1,200	450	250	5 or less	5	10
2,200	900	500	10 or less	10	25
All other				25	100

¹In a 5-year frequency, 24-hour duration storm.

²Including both principal and auxiliary spillway.

Table 3. – Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop-drainage structure.

Maximum drainage area for indicated rainfall*			Vertical drop	Frequency of minimum design, 24-hour duration storm	
0 – 3 in.	3 – 5 in.	5+ in.		Receiving channel depth	Total capacity
-----acres-----			ft	ft	yr
1,200	450	250	0 – 5	0 – 10	--
1,200	450	250	5 – 10	10 – 20	10
2,200	900	500	0 – 10	0 – 20	25
All other					50

* In a 5-year frequency, 24-hour duration storm.

Island-type structures. If the principal spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the principal spillway should carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum auxiliary spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the top of the embankment or side dikes. Side dikes shall extend downstream to a point where reentry flows will not effect the principal spillway system. Provisions must be made for safe re-entry of bypassed flow as necessary.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions.

General criteria. Earth embankment and auxiliary (earth) spillways of structures shall meet or exceed the requirements specified in Ponds (378) or Technical Release 60 (TR-60). Any structure that does not meet the criteria provided under the standard for Ponds (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to safely pass the total capacity flow indicated in Tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Necessary

sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative coverings such as gravel or other mulches may be used.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for constructing and vegetating this practice to achieve its intended purpose.

Preparation of construction drawings and specifications will follow procedures in the Engineering Field Handbook, Chapter 5, "Preparation of Engineering Plans"

Construction and material specifications used for grade stabilization structures will be PL-46 specifications.

The specifications for revegetating the embankment and auxiliary (earth) spillway areas shall be developed in accordance with the requirements for "Critical Area Planting" and "Mulching" NRCS Standards 342 and 484, respectively.

CONSIDERATIONS

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas

should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

necessary it can be modified to fit individual site conditions

In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources.

Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat.

Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

Special consideration should be given to maintaining or improving habitat for fish and wildlife where applicable.

The earth embankment structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Consider protective guardrails, warning signs, fences, or lifesaving equipment *be* added as needed.

OPERATION AND MAINTENANCE

A comprehensive maintenance plan, carried out by the owner will enhance the useful life of the grade stabilization structure. The owner or other responsible persons must be advised of their responsibilities and be counseled as to timing of maintenance inspections and methods of performing maintenance.

See pages M-410-1 and 2 for an example Operation & Maintenance (O & M) plan. For most grade stabilization structures this example will suffice for the O & M plan. When

REFERENCES

FIELD OFFICE TECHNICAL GUIDE (FOTG), SECTION IV, PRACTICE STANDARDS & SPECIFICATIONS

342 Critical Area Treatment
 378 Ponds
 399 Fishpond Management
 430 Pipeline, irrigation
 516 Pipeline, livestock

ENGINEERING FIELD HANDBOOK

EFH Chapter 2, Hydrology, including the Emergency and Principal Spillway Proportioning Guide
 EFH Chapter 3, Hydraulics
 EFH Chapter 4, Elementary Soils Engineering
 EFH Chapter 5, Preparation of Engineering Plans
 EFH Chapter 6, Structures
 EFH Chapter 7, Grassed Waterways & Outlets
 EFH Chapter 11, Ponds and Reservoirs
 EFH Chapter 13, Wetland Restoration
 EFH Chapter 17, Construction & Construction Materials

NATIONAL ENGINEERING HANDBOOK

SECTION 3, Sedimentation (Chapter 3, Erosion), (Chapter 6, Sources, Yields, Delivery Ratios),
 (Chapter 8, Storage Design Criteria)
 SECTION 8, Engineering Geology (Chapter 5, Classification of Structure Sites)

TECHNICAL RELEASES

TR-56, Wave Protection For Earth Dam Embankment
 TR-69, Riprap For Slope Protection Against Wave Action
 TR-77, Design & Installation of Flexible Conduits